# Control of Weeds at a Pinyon-Juniper Site by Seeding Grasses

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**Abstract** — An area seeded to perennial grasses and an adjacent nonseeded area both within a burned Colorado pinyon/Utah juniper (*Pinus edulis* Engelm./*Juniperus osteosperma* [Torr.] Little) community provided an opportunity to contrast frequency of plant species in the two treatments. Lower frequencies for cheatgrass (*Bromus tectorum* L.) and yellow salsify (*Tragopogon dubius* Scop.), which are introduced annuals, were found in the seeded area. Abundance of musk thistle (*Carduus nutans* L.), a noxious weed in Utah, was found at much reduced density and frequency where the burn had been seeded compared to where the burn had not been seeded. Higher frequency for squirreltail (*Elymus elymoides* [Raf.] Swezey), which is a native perennial grass, was found in the seeded area compared to the nonseeded area. Management implications include the need for advanced collection and storage of seed to supply the need for seeding large burns to prevent dominance of cheatgrass and other invasive weeds in these burns.

Introduced weedy plants present a formidable challenge to the management of native plant communities. Indeed cheatgrass (*Bromus tectorum* L.) seriously challenges the concept of maintaining native plant communities in some areas such as on the Snake River Plain and valleys and foothills of the Great Basin. Once established it is perpetuated by high fire frequencies by which it is able to exclude sagebrush and other native species (Peters and Bunting 1994). Some other introduced plants are also highly competitive including those on noxious weed lists of various states such as musk thistle (*Carduus nutans* L.). Control of these species has become a major concern where they now dominate thousands of acres and result in great economic loss (Leistritz and others 1996; Whitson and others 1991).

While some of these species are competitive at higher elevations in aspen and spruce-fir belts, cheatgrass is generally not. However, the thermal belt of Colorado pinyon (*Pinus edulis* Engelm.) and Utah juniper (*Juniperus osteosperma* [Torr.] Little) is prime habitat for cheatgrass. Coupled with the nature of pinyon-juniper to greatly oppress native understory species and outlive the seed banks of these species (West and Van Pelt 1987), the explosive ability of cheatgrass to increase after disturbance (Young and Evans (1978) presents a scenario in which it is difficult to apply a concept of native plant communities. Disturbance is usually a matter of "when" more than of "if." When disturbance comes to mature and old stands of pinyon-juniper they are left wide open to the invasion of cheatgrass and other invasive weeded species by the general lack of native understory species that is a function of pinyon-juniper stand closure (Everett 1987; West and Van Pelt 1987).

With an expanding human population of increasing mobility, the spread of weeds can be expected to remain at high levels and probably increase. This scenario has and will continue to complicate the maintenance of native plant communities. Applying a concept of wilderness or natural areas where disturbance by humans is hopefully omitted, will not always adequately address this challenge. Some of these plants have shown ability to enter and increase on sites where disturbance by man is minimal.

Kindschy (1994) reported the presence and increase of cheatgrass in southeastern Oregon's Jordan Crater Research Natural Area that has been protected from human activities including livestock grazing. Tausch and others (1994) found cheatgrass has displaced native perennial species on Anaho Island in Nevada despite a general absence of human-caused disturbance and fire. They attributed the increase to the competitive ability of cheatgrass. Young and Tipton (1990) cited two works from southeastern Washington that documented observations of cheatgrass successfully inserting itself into climax perennial grass/shrub communities that had been protected from fire and grazing for as long as 50 years. They proposed the idea of cheatgrass spreading in a biological vacuum created by grazing may be somewhat misleading or overstated. Goodrich and Gale (these proceedings) reported high frequency of cheatgrass on two sites with little apparent use by non-Native Americans or their livestock that are within 2.4 and 5.6 km (1.5 and 3.5 miles) of this study site. Knight (1994) reported the cheatgrass problem is not restricted to land managed for livestock, and he gave an example of an increase of cheatgrass following fire in Little Bighorn Battlefield National Monument in southern Montana. He suggested that managing vegetation of a National Monument so it reflects presettlement conditions is a goal that may be impossible once certain introduced species become established.

In addition to the ability of cheatgrass to invade some native plant communities without disturbance, the reality of the modern world includes international travel, high speed freeways, and a maze of other paved and dirt roads. Vehicles are a major means by which seeds are spread. Within a day, modern travel can carry seeds not only across major drainages but across oceans. It is common for seeds from vehicles to be deposited in disturbed areas where there is comparatively high probability for establishment. Northam and

In: Monsen, Stephen B.; Stevens, Richard, comps. 1999. Proceedings: ecology and management of pinyon-juniper communities within the Interior West; 1997 September 15–18; Provo, UT. Proc. RMRS-P-9. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

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Callihan (1994) examined five exotic annual grasses of recent introduction to the inland Pacific Northwest. Their work indicates the introduction of alien species continues and their dispersal has been enhanced by human transportation technology. The seeds of musk thistle and some other weedy species are highly adapted to transport by wind. This feature also indicates a continuing spread of these species. The ability of invasive weeds such as cheatgrass to spread and greatly alter ecosystem function indicates high priority for dealing with these species.

## Features and Recent History of the Study Location

The study site is within the North Skull Creek Burn of 1976, in the Green River corridor near Flaming Gorge in Daggett County, Utah, about 6 miles northwest of the town of Dutch John, within the Uinta Mountain Section as defined by McNab and Avers (1994). Annual precipitation at the Flaming Gorge Weather Station (near Dutch John) is 31.75 cm or 12.50 inches (Ashcroft and others 1992). The study site is within a landtype composed of ridge and ravine topography underlain by Precambrian quartzitic materials and shales of the Uinta Mountain Group. Within the landtype there are two general phases. One phase is on northerly exposures where alder-leaf mountain-mahogany/bluebunch wheatgrass (*Cercocarpus montanus* Raf./*Elymus spicatus* [Pursh] Gould) communities of high plant diversity are seral to pinyon and juniper. The other phase is on southerly exposures where communities of rubber rabbitbrush (*Chrysothamnus nauseosus* [Pallas] Britt.), sagebrush (*Artemisia* L,) and grasses are seral to pinyon-juniper. On the southerly exposures cheatgrass has proven to be a highly competitive plant. It is less competitive on the northerly exposures.

History of the site included livestock grazing up to about 1972. Livestock grazing was not permitted at this study site from before the burn of 1976. Although livestock had grazed the area in earlier decades, age and crown closure of trees prior to burning indicate little forage production inside the stand prior to European settlement. Livestock would not have been highly attracted to the site due to distance to water as well as low forage production. A stock watering pond had been constructed near the site, but it rarely held water.

The burn site is at 2,134 to 2,256 m (7,000 to 7,400 ft) elevation on a southerly exposure with gradients of 10 to 50 percent. The study site within the burn is on gradients of 10 to 20 percent. The burn was not seeded following the 1976 fire. The decision not to seed reflects the attitude that without livestock, native plants would occupy the site after burning. However, occupation of dense stands of pinyon and juniper had exceeded the life span of seed banks for most species. Response of native plants was low. Within a decade cheatgrass dominated the site. Other introduced plants became abundant including musk thistle, which is included on noxious weed lists for several Western States. The aggressive nature of this plant allows it to spread rapidly forming extremely dense stands that crowd out other species (Whitson and others 1991).

The site was serving as a source of weed seed to spread to other areas. It was prescribed burned again on June 27, 1990, when cheatgrass seed was mature but had not yet shattered. The prescription was intended to reduce cheatgrass long enough to facilitate establishment of seeded species. The burn was aerial seeded in fall 1990 with a mixture of grasses and forbs. However, parts of the burn were missed in the seeding, which allowed a comparison of adjacent seeded and unseeded areas. The seed mix included aggressive, introduced grasses such as crested wheatgrass (*Agropyon cristatum* [L.] Gaertner), intermediate wheatgrass (*Elymus hispidus* [Opiz] Meld.), orchardgrass (*Dactylis glomerata* L.), and smooth brome (*Bromus inermis* Leysser).

## Methods

Six growing seasons after the 1990 burn and seeding, five 30.5 m (100 ft) belt lines were established in each of the seeded and nonseeded areas of the burn along which samples were taken in 100 frequency plots. Rooted nested frequency for all species present was determined in each of four nested plot sizes at each of the 100 plots as outlined by U.S. Department of Agriculture, Forest Service (1993). The method allowed for a score of 400 for each species. Scores for the more frequent species are shown in table 1. Also the number of musk thistle plants were recorded in 0.91 by 30.5 m (3 by 100 ft) macro plots along each of the belt lines for a total sample area of 0.0139 ha (0.0344 acres).

## Results

There were 26 and 270 musk thistle plants in the five macro plots for the seeded and nonseeded areas, respectively, or 1,871 and 19,424 plants per ha (756 and 7,849 per acre) in the seeded and nonseeded areas, respectively. Six growing seasons postseeding, the nonseeded area supported 10 times more musk thistle plants than did the seeded area.

Nested frequency scores were significantly higher in the nonseeded area than in the seeded area for cheatgrass, musk thistle, yellow salsify (*Tragopogon dubius* Scop.), and Canada

**Table 1**—Nested frequency scores for eight species. Based on a potential score of 400

| Plant species | Seeded area | Nonseeded area |
|---|---|---|
| Cheatgrass | 309 | 347 |
| Musk thistle | 6 | 44 |
| Yellow salsify | 66 | 126 |
| Canada thistle | 0 | 28 |
| Squirreltail[a] | 178 | 133 |
| Crested wheatgrass[a] | 75 | 5 |
| Intermediate wheatgrass[a] | 66 | 3 |
| Orchard grass[a] | 76 | 6 |
| Smooth brome[a] | 49 | 0 |
| Other annuals and biennials | 1 | 26 |
| Other herbaceous perennials[a] | 97 | 79 |

[a]Herbaceous perennial species excluding Canada thistle.

For all species of this table, the spread in scores between the twp areas is indicated to be significant at 80 percent probability (Chi Square = 1.642 with 1 degree of freedom).

thistle (*Cirsium arvense* [L.] Scop.). Scores were higher in the seeded area for squirreltail (*Elymus elymoides* [Raf.] Swezey) and for crested wheatgrass, intermediate wheatgrass, orchardgrass, and smooth brome (table 1).

## Discussion

Reduced frequency of weedy species was found in the seeded area. With the exception of Canada thistle, perennial, herbaceous species had higher frequency scores in the seeded area. The seeded and nonseeded sites were adjacent to each other and conditions were very similar at each site. However, some species could have been more abundant at one site than the other prior to treatment. This is most likely for squirreltail and Canada thistle. The invasive nature of cheatgrass indicates it had near equal frequency across the two sites prior to treatment. Musk thistle and yellow salsify are annual or biennial weeds with highly mobile seeds. The high mobility of the seeds and annual or biennial habit of these plants indicate these two species can be expected to have equal distribution in the seeded and nonseeded areas. Although Canada thistle has highly mobile seeds, there seems to have been little recruitment of this perennial species by seed since the second burn. Persistence and advance of this species is expected to be largely a function of its robust rhizomes. This plant is expected to have been most common in the unseeded area prior to seeding. The difference in scores for this species is not expected to be a function of seeding.

Much of the reduction of the introduced annual and biennial plants including cheatgrass appears to have been a function of seeding perennial grasses. The difference in nested frequency scores for cheatgrass between the seeded and unseeded areas might appear too small for an obvious shift in dominance of this species to a greatly reduced position in the community. However, comparison of the total scores for perennial herbaceous species between the two areas indicates the wide difference in the communities. Total scores for perennial herbaceous species excluding Canada thistle were 541 for the seeded area and 226 for the unseeded area. Difference in cheatgrass between the seeded and unseeded sites goes beyond frequency. Size of cheatgrass plants was also reduced in the seeded area. Davis and Harper (1990) also reported reduction of weedy plants concurrent with establishment and increase of seeded species at a juniper-pinyon site in central Utah.

## Management Implications

The explosively invading, highly competitive nature of cheatgrass (Pyke and Novak 1994; Harris 1967; Hironaka 1994; Nasri and Doescher 1995a,b; Young and Evans 1978; Evans and Young 1978) and especially on southerly exposures (Monsen 1994) might have been expected prior to the 1976 burn at North Skull Creek. However, much of the literature dealing with the competitive ability of this plant has come since that time. The decision not to seed following the 1976 fire seems to reflect the perception of that time that the native flora would dominate the site in the absence of livestock. However, the ability of cheatgrass to drive community dynamics goes beyond the influence of livestock grazing as discussed at the first of this paper. On some sites, it is a better competitor for soil moisture than are some widespread, highly successful native, perennial grasses including bluebunch wheatgrass (Harris 1967; Hironaka 1994; Pyke and Novak 1994) and Idaho fescue (*Festuca ovina* var. *ingrata* Hackel ex Beal) (Nasri and Doescher 1995b).

The ability of cheatgrass to drive plant community dynamics on pinyon-juniper sites as well as sagebrush sites presents a formidable challenge to maintenance of native plant communities. It is becoming increasing apparent that in some places plant communities will not be as they were before the advent of cheatgrass and other Eurasian introductions. South-facing slopes of pinyon-juniper ecosystems are one of these places. Super dominance (West and Van Pelt 1987) that comes with long-term occupation of pinyon-juniper trees of high percent crown closure leaves a depauperate understory that is essentially unable to respond after fire with the rapidity needed to compete with cheatgrass. Closed stands of pinyon and juniper are often quite effective in keeping cheatgrass at low levels. However, cheatgrass has inserted itself into these stands and has become wide spread in the pinyon-juniper ecosystem. Young and Evans (1978) found density of cheatgrass plants increased from 10/$m^2$ the first year after fire to 10,000/$m^2$ by the third year. Fire in dense stands of pinyon-juniper sets the stage for this kind of cheatgrass response. Fire in woodlands is more often a matter of "when" than "if." Eventually, many stands burn and are then exposed to cheatgrass and other weedy, introduced species.

Response to this situation includes doing nothing in which case, dominance of cheatgrass is strongly indicated by its past performance. Seeding can greatly decrease the influence of cheatgrass, but this is not likely to exclude it. Currently some of the most competitive plant materials for which seed is available in quantities sufficient to respond to large fires are of Eurasian origin. In recent years seeding these species has become increasingly objectionable because of their origin. However, this presents a dilemma of "choose your alien." The choices are a dominance of the annual cheatgrass or a mixture of perennial species of which some of the most likely to compete with cheatgrass are of Eurasian origin.

This dilemma points to the urgent need to develop native plant materials that are more competitive with cheatgrass. Until such materials are developed and of sufficient quantity to respond to large fires, introduced species such as those used in the 1976 North Skull Creek Burn seem to provide an alternative to cheatgrass. For 1996, Roberts (these proceedings) reported over 6 million acres burned in the United States through unplanned ignitions with over 2 million of these acres on lands administered by the Bureau of Land Management where over 300,000 acres were included in Emergency Fire Rehabilitation projects. Many of these fires were on lands dominated by pinyon-juniper and cheatgrass communities. Over 200,000 acres of pinyon-juniper-cheatgrass range burned in central Utah in 1996. The scale of these projects went far beyond availability of seed of native species.

The concept of using seed of local, native plants only to preserve pure local ecotypes without contaminating their gene pools has become an issue for rehabilitation projects. This concept might be practical for small projects and especially outside the ecological range of cheatgrass and other highly aggressive, invasive species. However, the scale of fires of 1996 demonstrates the futility of demanding seed of local natives only for use in seeding large burns. The ability of cheatgrass to increase from 10 to 10,000 plants per square m from the first to the third year postfire (Young and Evans 1978) demonstrates the need to apply seed in the year of the burn. This requires advanced storage of seed for rehabilitation projects. The critical need for advanced storage and early application of seed will be difficult to supply under a concept of "on site" collected seed of "pure" local natives. This concept is plagued by the uncertainty of specific sites of future fires. It is also difficult to apply after locations of fires are known. After fire, it is too late to collect abundant seed from the specific site. The year in which a fire burns can be a poor year for seed in areas adjacent to a burn.

Cheatgrass and other aggressive introduced weedy plants seriously challenge the concept of maintaining some native plant communities including many within the pinyon-juniper belt. Responding to these weedy plants might require looking beyond our traditional fascination with native plant communities, and especially if that fascination is based on a concept of "pure native" where "pure" implies native communities of local gene pools without influence of outside forces.

American isolation from the Old World, if it ever existed, stopped in 1492. The incidence of introductions and distribution of plants as a function of travel and Eurasian occupation has increased greatly since than time. Some of the introductions are simply better competitors in some environments than are natives. Or at least these introductions are aggressive enough to insert themselves into and maintain themselves in native plant communities that then are no longer native in a pure sense. Knight (1994) has suggested that management of vegetation so it reflects pre-European settlement conditions is a goal that may be impossible once certain species become established. His suggestion combined with the catastrophic and large-scale change induced by cheatgrass and other weedy species in the Great Basin (Billings 1994) and Snake River Plain (Peters and Bunting 1994) vividly portray the potent ecological force of cheatgrass.

Standards for plant communities within the pinyon-juniper belt based only on natives and especially only local natives could reflect more romanticism than realism. We agree with Young's (1994) evaluation that: "The inherent variability in bluebunch wheatgrass and related native species is a vital part of the cheatgrass range restoration picture. If the genotypes cannot be found in bluebunch wheatgrass populations, which can compete with cheatgrass, then range restoration is dependent on: (1) reestablishment of high-technology weed control systems, (2) hybridization of bluebunch wheatgrass with relatives such as quackgrass (A. repens ) [*Agropyron repens* L.] that are not native, followed by selection for competitive ecotypes, or (3) accept exotic hybrids that are competitive."

At the North Skull Creek Burn, native plants, in the absence of livestock, did not prevent cheatgrass dominance or an abundance of musk thistle. The seeding at the North Skull Creek Burn demonstrates the ability of crested wheatgrass and other introduced perennial grasses to reduce cheatgrass and musk thistle to subordinate positions in plant communities. These highly successful plant materials are the product of hundreds of years of selective breeding for high seed production, ease of harvest, vigorous germination, rapid establishment, high production, and other features. Establishment of these species and reduction of cheatgrass indicates a reduced fire frequency that can facilitate increased of sagebrush and other native species including pinyon and juniper. Fire frequency typical of cheatgrass dominated lands is commonly too high to allow for the return of native woody species.

In response to fires of 1996, many thousands of pounds of seed of introduced species were used not because managers prefer them over natives, but because seed of suitable natives was not available. It is not the intent of this paper to recommend continued use of introduced species for seedings. However, until large quantities of seed of native species with the ability to compete with and suppress cheatgrass are available, the introduced species seeded at North Skull Creek Burn provide an alternative to cheatgrass dominance. This and the relatively low cost of seed of these species will continue to appeal to those faced with the reality of large burns in cheatgrass-prone areas.

Quantities of native seed adequate to supply the need following large fires in fire seasons such as 1996 can be facilitated by the methods that have put seed of introduced species in abundant supply. Selecting for high seed production, ease of harvest, vigorous germination, and rapid establishment and advanced harvest and massive storage of seed to be used in regional areas and not necessarily local areas might not fit well into a pure, local, native concept. However, the challenge presented to such a concept by cheatgrass and other aggressive, introduced , weedy species seems catastrophic. This challenge has been met by selection and marketing that has put seed of successful, perennial, introduced species in abundant supply. Similar selection and market development of native species is strongly indicated as a vital part of rangeland restoration including control of noxious weeds and other highly invasive species.

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